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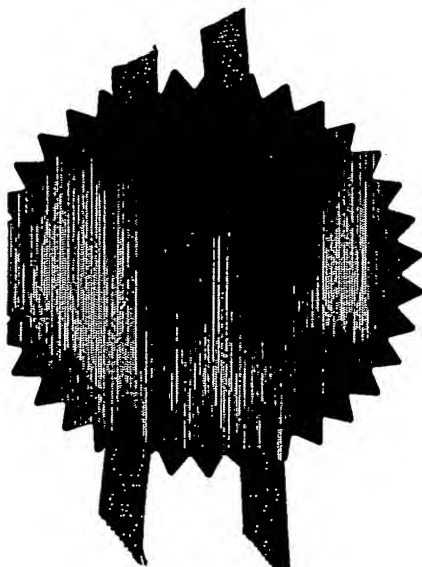
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1. Your reference HL80825

2. Patent application number  
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0130978.0

27 DEC 2001

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Flying Null Limited  
Harston Mill  
Harston  
Cambridge  
CB2 5GG

Patents ADP number (if you know it)  
If the applicant is a corporate body, give the country/state of its incorporation

United Kingdom

07070519002

4. Title of the invention  
Verification Key for Replacement Parts

5. Full name of your agent (if you have one)

Haseltine Lake & Co.

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Imperial House  
15-19 Kingsway  
London WC2B 6UD

Patents ADP number (if you know it)

34001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
(if you know it)

Date of filing  
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7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
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8. Is a statement of inventorship and of right to a grant of patent required in support of this request? (Answer "Yes" if:  
a) any applicant named in part 3 is not an inventor, or  
b) there is an inventor who is not named as an applicant, or  
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Yes

# Patents Form 1/77

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Continuation sheets of this form

Description	9
Claim(s)	3
Abstract	om
Drawing(s)	3+3

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Translations of priority documents

Statement of inventorship and right to a grant of patent (*Patents Form 7/77*)

Request for preliminary examination and search (*Patents Form 9/77*)

1 ✓

Request for substantive examination (*Patents Form 10/77*)

Any other documents  
(please specify)

11. I/We request the grant of a patent on the basis of this application

Signature

Date

Haseltine Lake Rlo.

27 December 2001

12. Name and daytime telephone number of person to contact in the United Kingdom

Elizabeth Rolfe

[020] 7420 0500

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Verification Key for Replacement Parts

5 The present invention relates to methods and apparatus  
for verifying the authenticity of, or ensuring the  
correct substitution of, replacement units which  
connect to a master device in order to facilitate the  
operation of that device.

10 Devices and systems which comprise a master unit and a  
replaceable unit, such as a printer and print  
cartridge, an electric toothbrush and head, or a  
vending machine and container, often suffer from the  
disadvantage that the replaceable unit can be replaced  
by inferior copies or substitutes. This can result in a  
15 reduction in the performance of the device or can  
reduce the quality of the delivered item. In some cases  
the user is not aware of the substitution, and will  
attribute the reduced quality to the provider of the  
original machine thus damaging the reputation of the  
20 supplier.

A similar problem can arise in a number of medical  
applications where the substitution of a poor quality  
replacement unit, or the incorrect substitution of a  
25 replacement unit, can have serious safety implications.  
For example, the administration of medication by means  
of a dispensing pump requires the correct connection of  
a medical infusion tube to the dispenser.

30 A number of techniques have been previously considered  
in order to prevent incorrect or inferior quality  
substitution of replacement parts. Mechanical  
interlocks have been employed which consist of two  
parts, one part being incorporated into the master unit  
35 and the other in the replacement unit so that the two  
parts must complement each other to allow the units to

be coupled together. Mechanical interlocks however, have the disadvantage that they are relatively easy to copy and so copy substitutes can be easily manufactured. Furthermore, the number of valid replacement parts will be quite limited and complicated mechanical interlocks can impair the convenient substitution of a replacement unit such as, for example, the removal of a spent printer cartridge and the replacement of a new cartridge.

Many products require the use of electronic controls to operate the device. In such cases it becomes possible to incorporate an electronic "key" into the replacement unit that will be detected by a detection apparatus coupled to the master unit. One such electronic key is illustrated in Figure 1 and consists of a programmable integrated circuit, programmed with a suitable code. This key can be read via a suitable electrical connector, or via a short range radio frequency transmitter/receiver arrangement. Such circuits can often provide a successful means of verifying the authenticity, or ensuring the correct substitution, of replacement parts. However, due to ready access to standard circuit production techniques, they are also moderately easy to copy. Furthermore, the cost of such devices can be significant and would be inappropriate for low cost replacement units such as disposable cups for a drinks vending machine.

Preferred embodiments of the present invention seek to alleviate the problems associated with previously known techniques by providing a low-cost electronic "key" that is difficult to reproduce and which can carry a number of codes that can be machine readable.

In cases where incorrect substitution of a replacement

part may still take place, or where a valid replacement unit may be incorrectly installed or become moved relative to the master unit, it is also desirable for embodiments of the present invention to be able to alert a user to the incorrect substitution, by causing the operation of the master unit to be modified.

According to one aspect of the present invention there is provided an apparatus comprising a master unit and one or more replacement units which connect to the master unit so as to facilitate the operation of said apparatus, the apparatus being provided with a verification means to determine the authenticity and/or the correct connection of the replacement unit, wherein if the replacement unit is not found to be authentic, or is incorrectly connected to the master unit, the operation of the apparatus is modified.

The verification means preferably comprises a remotely detectable tag, such as an optical or magnetic tag, which is provided in or on the replaceable unit. A detection system is then provided in the master unit which will excite the tag when the replaceable unit is brought into proximity with the master unit, and which also provides a means to detect the response of the tag to the excitation means.

Preferred embodiments of the invention employ the use of a magnetic tag having one or more pieces of magnetic material, the tag being incorporated in, or provided on, the replaceable unit. A number of tag embodiments are known such as those described in WO 97/04338 and WO 96/31790, the disclosures of which are incorporated herein by way of reference thereto.

The master unit is then preferably provided with a

detection system comprising a means to generate a magnetic interrogation field, to which the magnetic tag will be subjected when the replacement unit is coupled to the master unit, and a means to detect the resultant magnetic response of the magnetic tag. The magnetic tag and the detection system thereby comprise the verification means. Furthermore, the master unit is advantageously provided with a signal processing means which can control the operation of the apparatus in accordance with the magnetic response of the tag.

Preferably, the magnetic material comprises low coercivity, high permeability ( $>10000$ ) magnetic material which is advantageously in the form of a thin film of less than 1 micron thick and which preferably has a typical coercivity of less than 10 Gauss. The magnetic permeability of the material exhibits a preferred axis of magnetisation so that when the material is excited with an ac magnetic field parallel to the preferred axis of permeability, the material will be easily saturated. The magnetic field of the saturated material will comprise a non-linear function of the interrogation field, and will consist of harmonics of the exciting field. The presence of these harmonics will indicate the presence of this material, and so the material can be introduced into a consumable as an electronic key. The detection of such material is non-contact, as no electrical connection is required.

In a further embodiment of the present invention the tag is constructed so that at least one of the features may be interrogated at a greater range than the other features of the tag. This may preferably be achieved by providing a tag with a plurality of elements wherein at least one of the elements is of greater length or width than the other elements. This embodiment of the present

invention has the advantage that the tag will exhibit two levels of encoded information. The first level may be relatively limited in content, but may be read at a greater distance or through the outer packaging of the replaceable unit. The second level, containing more detailed information, can be read only when the replaceable unit is removed from the packaging or the unit is brought within a specified distance from the master unit housing the interrogation means.

For a better understanding of the present invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows an apparatus having a master unit and a replacement unit and incorporating a verification means according to the prior art;

Figure 2 shows an apparatus having a master unit and a replacement unit and incorporating a verification means according to an embodiment of the present invention;

Figure 3 shows a further embodiment of the present invention; and

Figure 4 illustrates an embodiment of the present invention in which the master unit comprises a drinks vending machine and the replaceable unit is a disposable cup.

The verification system shown in Figure 2 comprises a replaceable consumable (7), having a magnetic tag (1) attached thereto. When the consumable (7) is correctly replaced in the master unit, it will be subjected to an interrogation system provided in the master unit (8).



The interrogation system provided in the master unit (8) comprises a transmit coil (2) to generate a magnetic field in the region where the tag will be, a receive coil (3) to receive the magnetic response of the tag to the transmit field, and front-end electronics (4) to generate the exciting field and amplify and process the signal from the received coil. The received signal is then passed to a signal detector (5), which identifies the presence of the signal, and produces a logic signal which is passed to the master unit controller (6). The master unit controller is arranged to modify or suspend the operation of the master unit if there is no electronic key detected, or if an incorrect or distorted signal is obtained. In this way, a user will be alerted to the substitution of an inferior quality replacement unit or an incorrect substitution of an authentic replacement unit.

In a number of further embodiments the tag can be encoded by having several pieces (or elements) of the magnetic element. The elements can be arranged on a substrate such that the spacing between them is employed to encode information between the tag. The magnetic properties of the elements may also be used as a further means to encode information so that some or all of the elements has a unique attribute.

Figure 3 shows an embodiment of the present invention in which a magnetic tag is provided on the replaceable consumable unit. This tag configuration (described in more detail in WO 97/04338) comprises a first layer (10) of magnetic material characterised by high permeability, low coercivity and a non-linear B-H characteristic. The low coercivity layer (10) is coated with a second layer (11) of magnetic material which is capable of being permanently magnetised so that it acts

as a magnetic bias region. When the tag is interrogated by an interrogation field generated by the transmit coil (13) and field bias coil (13), the low coercivity layer will only be driven out of saturation when the magnetic bias level of the neighbouring layer (11) is overcome. In more complex tag configurations, the said second layer of magnetic material can comprise three or more discrete regions of magnetic bias material and each of the discrete regions can exhibit a different combination of magnetisation level and direction such that, during interrogation by a constant frequency alternating magnetic field, the magnetic bias levels of each of said discrete regions are overcome at different times in the interrogation cycle so that the value of magnetic bias field required to overcome the high coercivity layer can uniquely identify the element(s).

The interrogation field in this embodiment comprises a high amplitude, low frequency scanning field, which is generated by the field bias coil (12), and is capable of overcoming the bias of the high coercivity layer (11). In addition, a low amplitude, high frequency field is generated to which the low coercivity layer (10) will respond when the neighbouring bias has been overcome by the scanning field. The high frequency field creates signals which are harmonics of the interrogation frequency and which are detected by the receive coil (14).

The master unit (15) is also provided with front-end electronics (16) to process the signal received by the receive coil (14). The received signal is then passed to a signal detector (17), which identifies the presence of the signal, and produces a logic signal which is passed to the master unit controller (18). The master unit controller is arranged to modify or suspend

the operation of the master unit if there is no electronic key detected, or if an incorrect or distorted signal is obtained. In this way, a user will be alerted to the substitution of an inferior quality replacement unit or an incorrect substitution of an authentic replacement unit.

A magnetic tag can also be encoded so that it may be used to act as more than just a presence indicator. For example the brush in an electric toothbrush may have different variants which require different speed settings in the motor. So the magnetic tag may provide two functions, first it acts as an electronic key, which is difficult to copy, and second it carries codes which can be interrogated and then conveyed to the master unit controller to control the operation of the master unit.

Figure 4 shows an embodiment of the present invention in which the master unit comprises a drinks vending machine and the replaceable unit is a disposable cup. The verification system is arranged so that the operation of the vending machine will depend upon the identification of the correct magnetic tag. The master control unit can be arranged to suspend the operation of the vending machine altogether, or may instead be arranged to alert the user in some other way, e.g. by going slow or by preventing the dispensation of an unauthentic cup.

In another embodiment, the tag consists of a number of elements arranged with defined gaps between them. The pattern of elements can be used to form a code, similar to an optical barcode. Such a tag has been disclosed in a previous patent application WO96/31790, and the elements are interrogated by means of a magnetic field,

known as a magnetic null field, which comprises a region of zero magnetic field which is contiguous with a region of high saturating magnetic field. The verification system will depend on measuring the response of a magnetic element to the different regions of the magnetic null field. When a given element is within the region of high magnetic field, it is completely saturated by an applied static magnetic field. However, when the elements enter the region of zero magnetic field, they are driven out of saturation and will respond to the change in magnetic field level by generating a harmonic of an applied ac magnetic field. By causing relative movement between the tag element(s) and the magnetic null field, signals will be produced at different time intervals which correspond to the arrangement of the magnetic elements on the tag.

This embodiment can be used to identify consumables in a situation where the consumable is moved relative to the master unit, such as a print cartridge and printer, where the tag both acts as an electronic key and carries a code which controls the master unit as shown in Figure 5. For example, the tag can be encoded and used to ensure that the correct colour cartridge is put in the correct slot in the printer. It can also be used to alter the print parameters, so that inferior cartridges without a tag will consequently be detected and the printer will then be limited in its function to slower or lower resolution operating modes.

CLAIMS:

1. An apparatus comprising a master unit and one or more replacement units which connect to the master unit so as to facilitate the operation of said apparatus, the apparatus being provided with a verification means to determine the authenticity and/or the correct connection of the replacement unit, wherein if the replacement unit is not found to be authentic, or is incorrectly connected to the master unit, the operation of the apparatus is modified.

2. An apparatus as claimed in claim 1, wherein the verification means comprises: i) a remotely detectable tag provided on, or incorporated in, the replacement unit; and ii) an interrogation means provided in the master unit for interrogating a replacement unit to determine the authenticity of that unit and/or determine if the replacement unit is correctly connected to the master unit, as indicated by the response of the remotely detectable tag.

3. An apparatus as claimed in claim 2, wherein the remotely detectable tag comprises one or more pieces of magnetic material.

4. An apparatus as claimed in claim 3, wherein the interrogation means comprises: i) a magnetic field generating means for generating a magnetic field in the region where the replacement unit will be connected; and ii) a means for detecting the response of the tag to said magnetic field.

5. An apparatus as claimed in claim 2, 3 or 4, wherein the tag comprises a plurality of discrete elements and wherein the elements represent two levels of encoded

information so that the content of one of the levels of encoded information is capable of being read by interrogation through the packaging of the replacement unit and/or interrogation at a greater distance from the interrogation means than the content of the other level of encoded information.

6. An apparatus as claimed in any one of claims 2 to 5, wherein the tag comprises a plurality of discrete elements which are arranged such that the relative positions of the elements represents information.

7. An apparatus as claimed in claim 6, wherein the information represented by the plurality of elements identifies the type of replaceable unit and wherein the operation of the master unit is modified in accordance with the type of replaceable unit which is or has been connected.

8. An apparatus as claimed in any one of claims 2 to 7, wherein the element(s) comprise low coercivity, high permeability magnetic material.

9. An apparatus as claimed in claim 8, wherein the element(s) are biased by an associated region of high coercivity magnetic material.

10. An apparatus as claimed in any preceding claim, wherein the master unit comprises an electric toothbrush handle and the replaceable unit comprises a brush.

11. An apparatus as claimed in any preceding claim, wherein the master unit comprises a printer and the replaceable unit comprises a printer cartridge.

12. An apparatus as claimed in any preceding claim, wherein the modification of the operation of the apparatus does not comprise preventing the operation of the apparatus.

5  
13. An apparatus as claimed in any preceding claim, wherein the operation of the apparatus comprising the master unit and the replacement unit serves a medical application.

10  
14. An apparatus as claimed in claim 13, wherein the master unit comprises a medicine dispensing pump and the replacement unit comprises a medical infusion tube.

15  
15. An apparatus as claimed in claim 13 or 14, when read as appended to any one of claims 1 to 11, wherein the modification of the operation of the apparatus comprises suspending the operation of the apparatus.

20  
16. An apparatus substantially as herein described with reference to Figures 2 to 5 of the accompanying drawings.

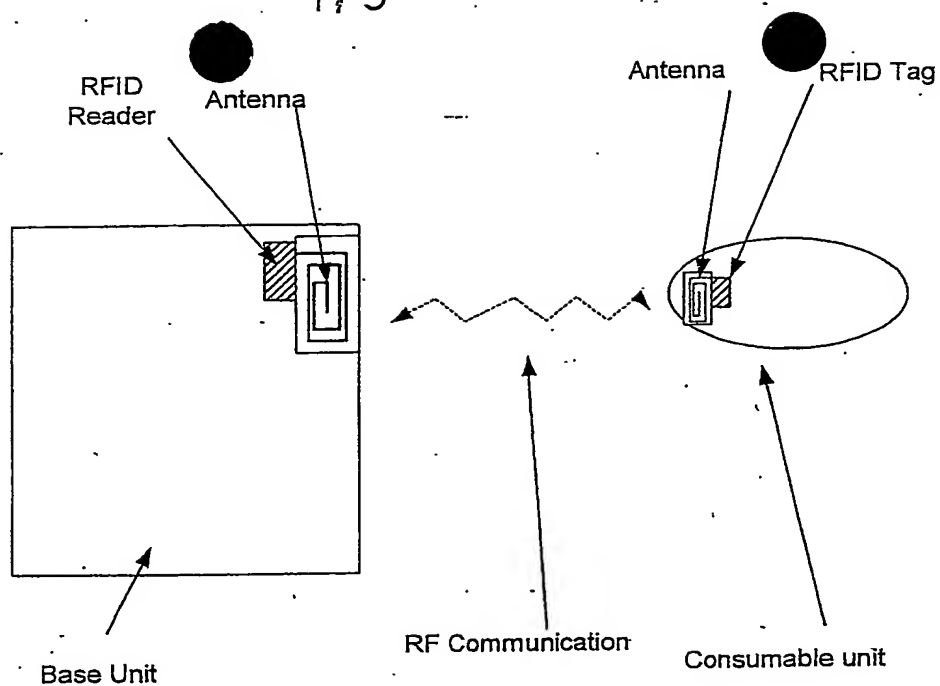


Figure 1

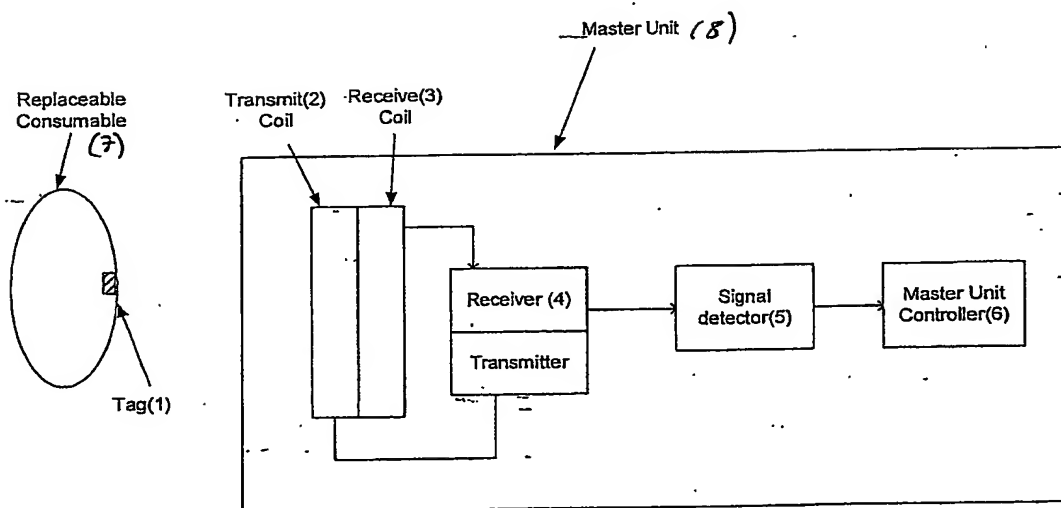


Figure 2



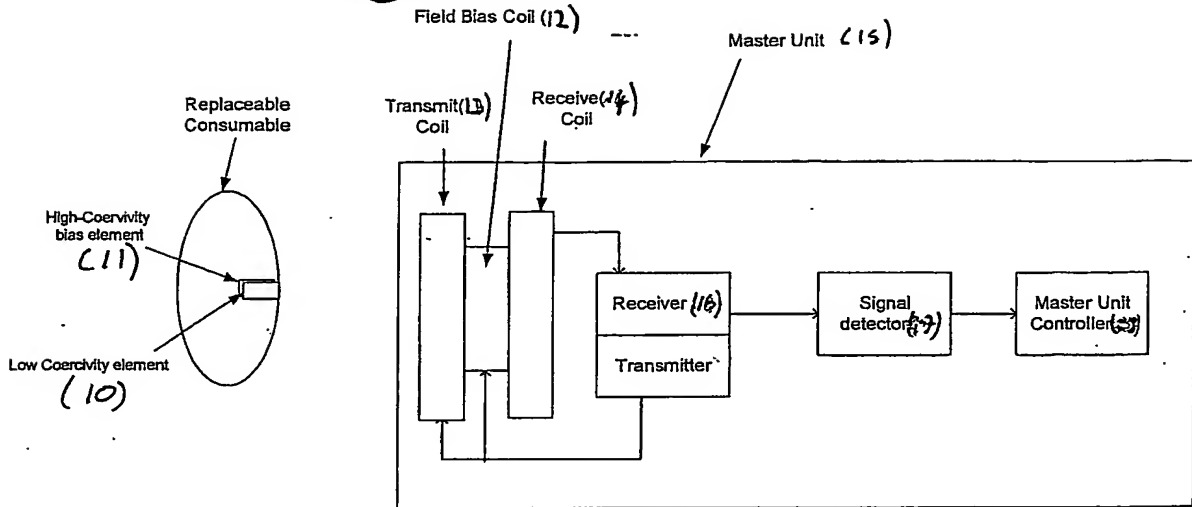


Figure 3

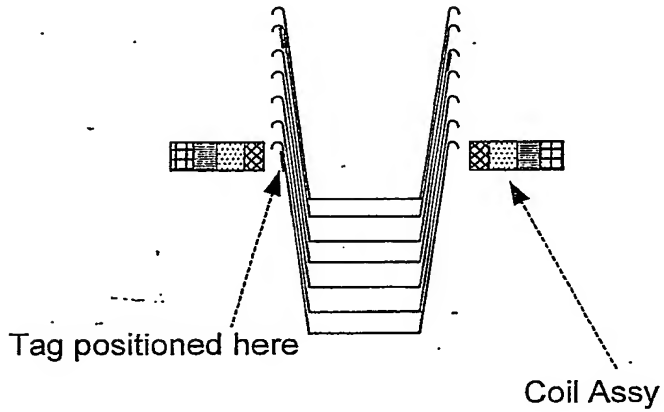


Figure 4

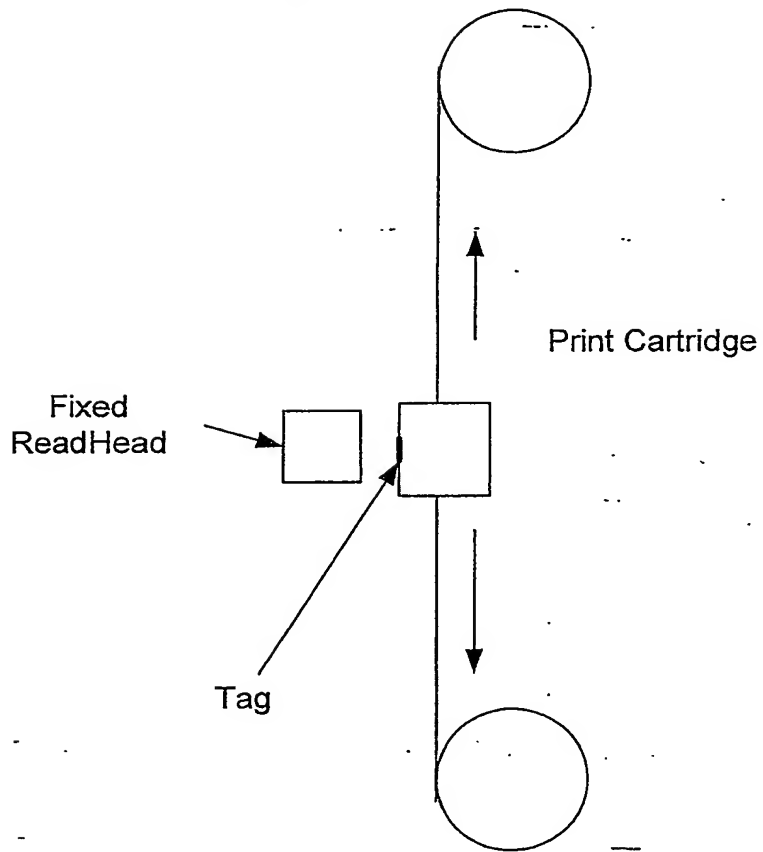


Figure 5

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